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A FIELD TEST OF THE EFFICACY OF MCH IN PREVENTING DOUGLAS-FIR INFESTATION BY DOUGLAS-FIR BEETLE

By

R. W. Thier[1]

Introduction

Douglas-fir beetle, Dendroctonus pseudotsugae Hopkins, is an important native insect pest of Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco). Infestations often develop first in trees damaged by wind, fire, or defoliation then spread to adjacent susceptible living trees (Furniss and Orr 1978) where outbreaks may develop.

Douglas-fir beetle has one generation annually. Adult beetles attack trees throughout the summer. Beetles bore through the bark depositing eggs in the phloem. Following egg hatch, the larvae feed in the phloem eventually girdling the tree. The brood remains under the bark throughout the winter where they develop into adults and fly the following year (Furniss and Orr 1978).

Colonization of a tree is regulated by beetle produced pheromones plus compounds released by the tree (Vite 1970). These chemical messages are not only responsible for aggregation, or mass-attack of a tree, but also antiaggregation to stop attraction and potential overcolonization and competition among broods (Knopf and Pitman 1972, McGregor et al. 1984).

Various beetle management strategies have been investigated. Thinning and harvesting of Douglas-fir stands provide the best means to prevent Douglas-fir beetle infestations but in many cases cannot be timely applied or are environmentally undesireable. Insecticides have been proven effective but

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[1] Entomologist, Forest Pest Management, Boise Field Office

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cannot be used everywhere, may be environmentally undesireable, or lack EPA registration. The use of synthesized pheromones has received increased attention for manipulating Douglas-fir beetle populations (Furniss and Orr 1978).

Pheromones for Douglas-fir beetle were first identified in the 1960's and 1970's. Their synthesis and testing soon followed. Compounds such as frontalin and alpha-pinene were tested and found to strongly attract adult beetles (Furniss et al. 1972, Knopf and Pitman 1972). Another pheromone, 3-methyl-2-cyclohexen-1-one (MCH), proved to be antiaggregative to Douglas-fir beetle (Furniss et al. 1974, Rudinsky et al. 1972). Controlled release formulations of MCH were further proven effective in reducing Douglas-fir beetle infestations in fallen trees (Furniss et al. 1977, McGregor et al. 1984).

This investigation field tested MCH on standing uninfested Douglas-fir where beetles were present. The objectives of the field test were to determine: (1) the efficacy of MCH to prevent Douglas-fir beetle infestation in the presence of Douglas-fir beetle baits containing both frontalin and alpha-pinene, and (2) the efficacy of MCH to prevent Douglas-fir beetle infestation in Douglas-fir stands.

Methods and Materials

Treatments were tested using a randomized block design. Treatments included (1) Douglas-fir beetle bait, (2) MCH, (3) Douglas-fir beetle bait and MCH, (4) experimental control. Each treatment was applied to a 2.5 acre block and replicated five times resulting in twenty 2.5-acre plots. Plots were square, 5 chains on a side, and spaced 5 chains apart.

The four plots within a replicate were planned to be as uniform as possible to avoid stand effects on the treatment. Douglas-fir was to constitute 75% or more of the stand and plots were to contain 3-10 infested trees. Perfect uniformity was not essential because treatment effects were to be based on percent of trees infested.

MCH and baits were obtained from Phero Tech Inc.. Baits contained a 1:1 mixture of frontalin and alpha-pinene. MCH was loaded in plastic bubble caps which daily released 0.5 mg of MCH.

MCH bubble caps were evenly spaced throughout the plots at the rate of 40 caps/acre in a grid pattern. Grid spacing was approximately 1/2 ch X 1/2 ch. Each cap was stapled to the bark, 6-7 feet above ground, on the north side of the tree that was closest to the grid coordinate regardless of tree species. Spacing was maintained as closely as possible.

Five Douglas-fir beetle baits were used in each of the baited plots. Baits were applied 6-7 feet above ground on the north side of 10" DBH or larger Douglas-fir. One bait was placed at the center of the plot and one each midway along the sides of the plot approximately 1 ch from the boundary of the plot.

In fall 1989, test plots were established in the Adams Creek drainage on the Weiser Ranger District, Payette National Forest, Idaho. Douglas-fir trees in this area had experienced chronic Douglas-fir beetle infestation for many

years. Installation was planned for the following spring but, because of delays in project funding and product availability, project implementation was delayed until spring 1991 in advance of beetle flight.

After beetle flight, in fall 1991, we examined all trees 5 inches DBH and larger on all plots. Species and diameter of each tree examined was tallied and each Douglas-fir was categorized as uninfested, killed prior to 1990, killed in 1990, or currently infested - 1991. Following data summarization analysis of variance was planned to detect statistical differences.

Results and Discussion

Douglas-fir dominated our plots, on average exceeding 84% Douglas-fir for each replicate, but two plots failed to meet the 75% Douglas-fir standard (Table 1). These two plots were only 69% and 70% Douglas-fir. Likewise, the variability with respect to percentage Douglas-fir was higher in replicates 4 and 5 than replicates 1, 2, and 3.

Stocking density ranged from 26.4 trees/acre to 139.2 trees/acre (Table 1). Average stocking density exceeded 41.2 trees/acre among the five replicates. Stocking density was not uniform among plots which, like species composition, was undesireable and may be a source of error.

Table 1. Stand characteristics before a test of the efficacy of MCH to prevent beetle infestation, Payette National Forest, Idaho, U.S.A, 1991.

Treatment	Replicate					$\bar{X}$	S.D.
	1	2	3	4	5		
Percentage Live Douglas-fir							
Douglas-fir beetle bait	91	100	97	70	100	91.6	12.62
MCH	100	100	100	96	97	98.6	1.95
Bait + MCH	100	100	98	83	69	90.0	13.73
Control	89	100	99	87	100	95.0	6.44
Combined $\bar{X}$	95.0	100	98.5	84.0	91.5		
S.D.	5.83	0	1.29	10.80	15.07		
Live Trees/Acre							
Douglas-fir beetle bait	58.8	50.0	46.8	109.2	63.6	65.7	25.24
MCH	47.2	37.2	43.6	89.2	31.6	49.8	22.84
Bait + MCH	72.8	37.6	69.2	30.8	43.2	50.7	19.07
Control	139.2	44.4	45.6	45.6	26.4	60.2	44.89
Combined $\bar{X}$	79.5	42.3	51.3	68.7	41.2		
S.D.	41.15	6.10	12.01	36.66	16.50		

The mean diameter of live Douglas-fir on plots prior to treatment ranged from 10.2" DBH to 20.2" DBH (Table 2). Although we applied no statistical tests, it appears that little difference exists among plots within a replicate with respect to the diameter of live Douglas-fir. On average, the live Douglas-fir on those plots treated with MCH alone were the largest and those on the bait only plots were the smallest.

Table 2. Diameter of live Douglas-fir before a test of the efficacy of MCH to prevent beetle infestation, Payette National Forest, Idaho, U.S.A, 1991.

Treatment	Replicate					
	1	2	3	4	5	Avg.
Douglas-fir beetle bait						
$\bar{X}$	10.7	10.8	15.5	10.2	15.0	12.44
S.D.	5.08	4.22	7.10	6.08	8.06	
MCH						
$\bar{X}$	15.4	13.9	19.0	13.0	20.2	16.30
S.D.	5.50	5.90	8.04	6.13	9.87	
Bait + MCH						
$\bar{X}$	13.0	12.4	16.6	17.5	16.6	15.22
S.D.	6.42	4.39	6.19	7.18	10.46	
Control						
$\bar{X}$	11.2	11.5	15.3	13.8	18.2	14.00
S.D.	4.08	5.13	6.61	8.31	6.05	
Combined						
Avg.	12.58	12.15	16.60	13.63	17.50	

Levels of Douglas-fir beetle activity on the plots before the test in 1990 were disappointingly low (Table 3). The majority of plots had no activity present in 1990. Only three of the 20 plots had any Douglas-fir beetle activity; however, the study plan required 3-10 infested trees on each plot. This violation of our study plan was probably the single most important factor preventing testable results.

During the evaluation we found few trees infested in 1991, even on the baited plots, again indicative of very low beetle populations in the area. Trees on three of the five baited plots sustained no attacks where one would expect at least the baited trees to be infested (Table 3). Without beetle attacks in our control plots, and little activity in the bait plots, no treatment effects could be shown and further analysis became pointless. On average, baited plots

sustained the most mortality in 1991, albeit low, and had a 200% increase in activity from 1990 to 1991 (Table 3). These were the only plots to experience an increase in activity. The MCH plots were the only plots that, on average, experienced a decrease in Douglas-fir beetle caused mortality. The trend was not consistent among the MCH plots where three of the four replicates experienced no mortality in 1990 or 1991 (Table 3). One cannot state that MCH was responsible for decreased activity. The other treatments, bait plus MCH and untreated control, experienced no attacks in 1990 and 1991. Again, no inferences can be made.

Table 3. Numbers of Douglas-fir killed per acre by Douglas-fir beetles before and during a test of the efficacy of MCH to prevent beetle infestation, Payette National Forest, Idaho, U.S.A, 1991.

	Replicate					
	1	2	3	4	5	Avg.
DFB bait						
Prior to 1990	0	0.4	0	0	0.4	0.16
1990	0.4	1.2	0	0	0	0.32
1991	1.2	3.6	0	0	0	0.96
% change, 1990-91	200	200	0	0	0	200.0
MCH						
Prior to 1990	0	0.4	0	0	0	0.08
1990	0	0.8	0	0	0	0.04
1991	0	0	0	0	0	0.0
% change, 1990-91	0	-100	0	0	0	-100.0
Bait + MCH						
Prior to 1990	0.4	0	0	0	2.0	0.48
1990	0	0	0	0	0	0.0
1991	0	0	0	0	0	0.0
% change, 1990-91	0	0	0	0	0	0.0
Control						
Prior to 1990	0	0	0	2.8	0.4	0.64
1990	0	0	0	0	0	0.0
1991	0	0	0	0	0	0.0
% change, 1990-91	0	0	0	0	0	0.0
Combined						
Prior to 1990	0.1	0.2	0	0.7	0.7	0.34
1990	0.1	0.5	0	0	0	0.09
1991	0.3	0.9	0	0	0	0.24
% change, 1990-91	200	80	0	0	0	160.9

This experiment failed to provide testable results due to the very low beetle populations. Because the antiaggregative effects of MCH are well supported in the literature (Furniss et al. 1974, 1977, McGregor et al. 1984, Rudinsky et al. 1972) and potential for utilization in live Douglas-fir stands is high, I feel this experiment should be repeated insuring that the planned methods are followed.

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